

# Chronology of the Events of the Samarqand “Observatory and School” Based on some Old Persian Texts: a Revision

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**Abstract:** In the 9<sup>th</sup> century c. A.H/15 c. A.D Ulugh Beg, the son of Shāhrukh, became the ruler of Samarqand and invited a group of astronomers and mathematicians to Samarqand to establish a school (*madrasa*) and observatory there. During the last century some historians of science dealt with the details of the events which occurred in that scientific circle and tried to identify the dates of the events concerning this circle.

It seems that some of these events have been neglected, or incorrectly dated by them. It mainly goes back to two reasons. The first one was the differences in citations between historical sources and the second one was the way in which the dates can be interpreted.

The present article follows three main aims. First of all, it provides a time table of the known events related to the scientific circle and observatory. Secondly it deals with the dated events in various historical Persian texts, based on possible different translations and interpretations. Thirdly we will discuss the possible different dates given by some researchers on these events and will distinguish those which may be more authentic. It is noteworthy to say that the Persian texts concerning the Samarqand School and Observatory are translated into English in this article for the first time.

**Keywords:** Samarqand, Samarqand Observatory, Samarqand School, Ghīyāth al-Dīn Jamshīd al-Kāshī

### Introduction

The Samarqand observatory in the history of observatories from the Islamic Period stands tall as a scientific institution or as a historical institution. Astronomical activities in the Samarqand Observatory can be introduced as an important school of astronomy in the late period of Islamic astronomy. After the Observatory of Maragha, Ulugh Beg (795/1394-853/1449), the governor of Samarqand and grandson of Teymūr, who was skillful in mathematics and astronomy, ordered some of the great scholars of his time to found a school and an observatory in Samarqand. He invited Ghīyāth al-Dīn Jamshīd al-Kāshī (from Kāshān, a city around 250 km south of modern Tehran), Mu‘īn al-Dīn al-Kāshī, Ṣalāḥ al-Dīn Qāḍī Zāda Rūmī and ‘Alī Qūshchī. Qāḍī Zāda and Qūshchī were in Samarqand before the foundation of the Samarqand observatory,<sup>1</sup> but Ghīyāth al-Dīn and Mu‘īn al-Dīn traveled from Kāshān to Samarqand upon the invitation of Ulugh Beg. According to Ghīyāth al-Dīn, the main plan of the Samarqand observatory was designed based on his comments.<sup>2</sup>

The main reason to found the Samarqand Observatory was some incoherencies that were seen between Ulugh Beg observations and those of al-Ṣūfī.<sup>3</sup> Ulugh Beg tells us in his *zīj* that, after revising al-Ṣūfī's values for the positions of the fixed stars, with the correction of precession, decided to observe all of the stars again

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<sup>1</sup> Qāḍī Zāda was seen in Shīrāz around 811/1408-9, and arrived in Samarqand around 814/1411-12 (Fazlioğlu, p. 25). He became one of the main teachers of the Samarqand School. The customs of the School were spread throughout Anatolia by one of his students named Faṭḥallāh al-Shirwānī who had received his diploma in 844/1440 under the supervision of Qāḍī Zāda in Samarqand (Ibid, pp. 36-49; Saliba, pp. 816-821; Ṭāshkubrīzāda, pp. 100-101).

<sup>2</sup> Al-Kāshī, *letters*, p. 65. The other reason could be that, Ulugh Beg had seen the building of the Marāgha Observatory in his childhood, Sayili, 1960, p. 39, (Sayili's annotations).

<sup>3</sup> It should be noted that al-Ṣūfī, took the positions of stars from Ptolemy's *Almagest*, with the correction of precession. Thus, Ulugh Beg's criticism (Ulugh Beg, ed. Sédillot, pp. 432-433) goes back to Ptolemy; however, he does not point to this fact.

(except for 27 ones which were invisible in Samarqand).<sup>4</sup> For this purpose he ordered to found an observatory near the school in Samarqand.

The building of the Samarqand observatory included three floors<sup>5</sup> and its internal walls were adorned with some pictures of constellations, a globe of the earth and the seven climates (*Aqālīm-e sab'a*).<sup>6</sup> The first director of the observatory was al-Kāshī, and after his death (in 832/1429?), Qāḍī Zāda undertook his position. Finally, after the death of Qāḍī Zāda (after 844/1440)<sup>7</sup>, Qūshchī led the observations as the last director of the observatory.<sup>8</sup> The period of his directorship is unclear to us; however, we know that he emigrated to the Ottoman territory, accustomed to the tradition of Samarqand, and died in 879/1476.<sup>9</sup> Since the foundation of the Samarqand Observatory was an important event in the 9<sup>th</sup>/15<sup>th</sup> century, several Persian historical sources have dated some of its details and events. But as we told before there are reasons leading us to believe that inconsistencies exist between the dates given by the sources. The first reason is the way used by the authors to write the dates. For example, some of the authors confused the date of Ulugh Beg's order to build the observatory with the date of the beginning of its activities. Another reason is the error of some historians in recording the correct dates. To solve this problem, we have compared the earliest histories and selected the most authentic one according to the other evidence which we have on hand. The last reason is to be found in the texts of the sources themselves. Since such sources were written around five centuries ago, the way the authors wrote is not the same as in contemporary Persian. Thus, it is very likely that some texts could be interpreted in different ways. To obtain an accurate interpretation, we had to notice the authors' "writing style" at the time. Naturally, solving these linguistic problems is difficult even for the Iranian natives nowadays.

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<sup>4</sup> Ibid., pp. 431-432.

<sup>5</sup> Bābur, p. 79.

<sup>6</sup> Kamāl al-Dīn Samarqandī, p. 238.

<sup>7</sup> Since Faṭḥallāh al-Shirwānī had received his diploma in 844/1440 under the supervision of Qāḍī Zāda in Samarqand (Fazlioğlu, pp. 36-49; Saliba, pp. 816-821), the date of Qāḍī Zāda's death should be sometime after 844/1440.

<sup>8</sup> Khānd Mīr, vol. 4, p. 21; Rūmlū, p. 458; Qorbani, 1375, p. 343; Fazlioğlu, p. 24.

<sup>9</sup> Dowlatshāh-e Samarqandī, p. 362; Tāshkubrīzāda, pp. 146-148; Qorbani, 1375, p. 362 (none of them mentions the precise date of Qūshchī's emigration to Ottoman territory).

### 1. The Known Old Persian Texts about the Samarqand Observatory

In this article we will revise some of the Persian historical essays which contain some information about the events related to Samarqand School and Observatory. No Arabic text dealing with the issue is known. Then, on the basis of our translation and interpretation of the sources (appearing in Appendix), we have tabulated the dates quoted in the texts related to the events of the Samarqand School and Observatory (table). In some cases, we cite the dates of some events that Sayili or other researchers have not mentioned.

The following is a list of the Old Persian texts that we revised and then translated them into English in this paper, with the date of their authors' life time span (see Appendix):

- *Khāqānī Zīj*, Ghīyāth al-Dīn Jamshīd al-Kāshī (d. 832/1429).
- *Zubdat al-Tawārīkh*, Ḥāfiẓ Abrū (d. 833 or 834/1430 or 1431).
- Ulugh Beg's *Zīj*, Ulugh Beg (795/1394–853/1449).
- *Zīj-e Jāmi'-e Sa'īdī*, Rukn al-Dīn Sharaf al-Dīn Āmulī (800/1398–860/1456).
- *Maṭla'-e Sa'dayn wa Majma'-e Baḥrayn*, Kamāl al-Dīn 'Abd al-Razzāq Samarqandī (816/1414–887/1483).
- *Tārīkh-e Rowḍat al-Ṣafā*, Mīr Khānd (837/1433–903/1498).
- *Tārīkh-e Ḥabīb al-Sīyar*, Khānd Mīr (880/1475–942/1534).
- *Lubb al-Tawārīkh*, Yaḥyā ibn 'Abd al-Laṭīf Qazwīnī (885/1481–962/1555).
- *Aḥsan al-Tawārīkh*, Ḥasan Rūmlū (937/1530–985/1577).
- *Samarīyeh*, Abū Ṭāhir Samarqandī (13<sup>th</sup> /19<sup>th</sup> Century).

### 2. The Samarqand Observatory in Modern Sources

Several historians of science have dealt with the issue of the Samarqand Observatory and its achievements including Salih Zeki (1864-1921, in *Āthār-e Bāqīyeh*), Vasilii Veladimirivich Barthold (1869-1930, in *Four Studies on the History of Central Asia*), George Sarton (1884-1956, in *An Introduction to History of Science*), E. S. Kennedy (1912-2009, in *A Survey of Islamic Astronomical Tables*), Aydin Sayili (1913-1993, in *Uluğ Bey ve Semerkanddeki İlim Faaliyeti Hakkında Gıyasüddin-i Kâşî'nin Mektubu (Ghiyāth al Dīn al Kāshī's Letter on Ulugh bey and the scientific Activity in Samarqand)* and *The Observatory in Islam*), Abu'l-Qasim Qorbani (1911- 2001, in *Kāshānī Nāma*), Mohammad Bagheri (b.

1950, in *From Samarqand to Kāshān*) and Ihsan Fazlioğlu (b. 1966, in “The Samarqand Mathematical-Astronomical School: A Basis for Ottoman Philosophy and Science”).

Among them, Sayili’s works present the most comprehensive information about the Samarqand Observatory as he devoted a chapter of his book to this matter. However, Sayili only quoted the dates of some events from earlier sources. Some of these dates are mentioned by other researchers as well. In the following part, we will analyze the given dates.

### 3. A Comparison between the Sources on Samarqand’s Observatory and School

Here we have tabulated the dates which are cited in primary and secondary sources for the events connected to Samarqand’s Observatory and School, and expressed our viewpoint about the most probable date for each event based on the mentioned texts and some other historical evidence.

**The Table**

The Event	The date/ dates which are mentioned in the Persian sources <sup>10</sup>	The most probable date of the event	The date/dates which are mentioned in modern sources
The first observation of the Three lunar eclipses observed by al-Kāshī in Kāshān	Al-Kāshī, (fol. 4 r.- 4 v.) Ms. India Office Library, 808/1406	808/1406	-
Order given to found the Samarqand School	Mīr: p. 5360, in 824/1421	824/1421	-
Starting date of the Samarqand school foundation	A <sub>Rūmlū</sub> : p. 262, in 824/1421 B <sub>Tāhir</sub> : p. 44, in 823/1420	824/1421	-
Date in which the building of Samarqand school finished	A <sub>Tāhir</sub> : pp. 44-45, in 828/1425 B <sub>Khānd</sub> : vol. 4, p. 21, in 824/1421	828/1425	-
Qāḍī Zāda and Qūshchī’s arrival to Samarqand	Āmulī: fols. 1v.- 2 r., Qushchī was in Samarqand before Qāḍī Zāda. ‘Abd:p.238, bef. 823/1420.	Before [but near] 823/1420	Fazlioğlu, p. 25: Qāḍī Zāda arrived in Samarqand around 814/1411-12 Sayili, 1960: p. 42, [Qāḍī Zāda arrived in Samarqand] shortly before

<sup>10</sup> In this table the letter A shows the very probable date and B shows the less probable one for the mentioned event. We have C, D and E alternatives only in one case.

			814/1411
Al-Kāshī's entrance to Samarqand	A <sub>Abd</sub> : p. 238, before 823/1420 Qazwīnī: p. 316, before 823/1420 B <sub>Abd</sub> : p. 238, in 823/1420	Before [but near] 823/1420	Sayili, 1960: p. 36, 823 or 824/1420 or 1421 Sayili, 1988: p. 261, just after the age of 25 Barthold: p. 131, between 1416- 1427
Formation a scientific group for observations (before the foundation of the observatory)	A <sub>Qazwīnī</sub> : p. 316, in 823/1420 B <sub>Ṭāhir</sub> : pp. 45-46, in 832/1429	823/1420	-
Order for the construction of the observatory	Ḥāfiẓ Abrū, vol. 4, p. 744, in 823/1420 Khānd: vol. 4, p. 21, in 824/1421 Mīr: p. 5360, in 824/1421	824/1421	-
End date of the observatory foundation and beginning date of the observations	A <sub>Amulī</sub> : fol. 1 v., in 830/1427 B <sub>Ṭāhir</sub> : pp. 45-46, in 832	830/1427	Sayili, 1960: p. 36, 824/1421
Al-Kāshī's death	In 832/1429 <sup>11</sup>	832/1429	Qorbani, 1368: p.9, 832/1429
Duration of observatory activities	Āmulī: fol. 2 r., 30 years and some more years	About 30 years and some more years	Sayili, 1988: p. 271, 30 years
Compilation of <i>Ulugh Beg's Zīj</i>	Ulugh: fol. 177 v., in ca. 841/1438 Ṭāhir: p. 46, in 841/1438	841/1438 Date of the Star table in <i>Ulugh Beg's Zīj</i>	Sayili, 1988: p. 272, 841/1438 Barthold: p. 133, beginning of 841/ 1437 Kennedy: p. 44, 843/1440
Qāḍī Zāda's death	-	After 844/1440	Fazlioglu: p. 25, after 6 Rabi' al-Thānī 844/ 13 September 1440
Destiny of Samarqand's Observatory	-	We conjecture that the end of the observatory's activities was around 860/1456 (?)	Barthold: p. 133-134 The observatory ceased its activities immediately after Ulugh Beg's death (853/1449)

<sup>11</sup> In the folio before 1r. of the India Office manuscript of the *Khāqānī Zīj* (ms. no. 430), we can find an Arabic note that in the morning of Wednesday, 19<sup>th</sup> of *Ramaḍān* of 832 A.H./21<sup>st</sup> June of 1429 A.D., al-Kāshī passed away.

By applying Benno Van Dalen's Software (CALH), this day was Tuesday, according the conventional lunar calendar.

#### 4. Commentary

The first interesting event based on the information gathered from the *Khāqānī Zīj* (see the table) is al-Kāshī's first observations of three lunar eclipses to compute the lunar mean motion the first of which occurred in 775 Y/808 A.H./1406 A.D. It can be supposed that al-Kāshī's age was no less than 20 years old at the time of the first eclipse. During year 823/1421, when he was invited to Samarqand, he was probably around 35 years old or more. Among historians of science only Sayili deals with the problem and states that at the time of his invitation, al-Kāshī was about the age of 25.<sup>12</sup>

A recently discovered fact found in the *Khāqānī Zīj* concerns the date of its star table as 801 Y/ 835 A.H. If we accept that al-Kāshī's death was in 832 A.H. this leads to a conflict; we can justify it by three hypotheses, the first one is that al-Kāshī's death was after 835, not 832 A.H.; the second is that the star table was modified by al-Kāshī's colleagues to set it up for 835 A.H. after his passing away. Since on top of the table, the value of correction for the precession of the equinoxes between Ptolemy's observations ( $\approx 138$  A.D.) and those of al-Kāshī's table (801 Y/835 A.H./1432 A.D.) is equal to  $19;36^\circ$ ,<sup>13</sup> the table was computed by al-Kāshī or his colleagues fairly well for 835 A.H.<sup>14</sup> The third reason could be that al-Kāshī completed his *Zīj* before 835 A.H., but adjusted the star table for a round year (i.e. 835) in the future. However, from al-Kāshī's *Khāqānī Zīj*, we learn that he had already dedicated his work to Ulugh Beg probably around 823/1420 or before, when he was still in Kāshān [?].

Another issue is the year in which Ulugh Beg ordered the construction of the observatory and school. It seems that both buildings began to be built simultaneously in 824/1422, because most of our sources mention this date, though some of them present 830 or 832 as the date of the observatory's foundation. Jamshīd al-Kāshī and Mu'īn al-Dīn al-Kāshī, upon the invitation of Ulugh Beg,

<sup>12</sup> Al-Kāshī presents the date in Yazdgirdī Calendar (Y).

<sup>13</sup> Al-Kāshī, *Khāqānī Zīj*, India Office (London), ms. 430, fol. 167r; Idem, Aya Sofya (Istanbul), ms. 2692, fol. 124r.

<sup>14</sup> Since in the Islamic astronomy the most authentic value for the motion of the precession of the equinoxes was found  $1^\circ$  per 66 year (al-Battānī, p. 192), the value of  $19;36^\circ$  confirms that al-Kāshī's table should be prepared for 1294 years after Ptolemy's observations, that is equal to 835 A.H./1432 A.D.

entered Samarqand in 823/1421 or before it, thus it is likely that the mentioned scientific circle was formed very soon (i.e., in 823/1422, see table). The construction of the observatory ended in 830/1428; however its permanence is unclear to us.<sup>15</sup> Here we have only two clues, one is the date of the star table in the *Ulugh Beg's Zij* (841/1439) and the second is Āmulī's citation that the Samarqand Observatory was active for thirty years and, additionally, even more years. However, we have not yet found any authentic source (s) concerning the destiny of the observatory and how it finally came to ruins.

### 5. Concluding Remarks

Using a comparison between some Old Persian texts about the Samarqand Observatory that were written by historians who lived shortly after the foundation of the observatory, we have some conjectures on the most probable dates for the events concerning the Samarqand Observatory. Although Sayili cited some of the dates in his valuable books, *Uluğ Bey ve Semerkanddeki İlim Faaliyeti Hakkında Gıyasüddin-i Kâşî'nin Mektubu* (*Ghiyâth al Dîn al Kâshî's Letter on Ulugh bey and the scientific Activity in Samarqand*) and *The Observatory in Islam*, we revised these dates, changed one case and added some more events based on other historical sources.

With regard to the table, Sayili cites neither the date for the foundation of the Samarqand School nor the date in which the scientific circle was formed before the foundation of the observatory, nor finally the date in which Ulugh Beg ordered the construction of the observatory. However, a scientific group was formed in Samarqand for observations (before the foundation of the observatory). It seems that the scientific group spent adequate time for the site selection.

According to a colophon in a short treatise<sup>16</sup> written by Mu'în al-Dîn al-Kâshî in 826/1423 in Isfahan, it is likely that he traveled there shortly after his stay in Samarqand. The most important achievement of the Samarqand Observatory was the *Ulugh Beg's Sulţânî Zij* (*Gürkânî Zij*) which was completed around 841/1438. The Samarqand Observatory was at the very least active for about 30 years or even more.

<sup>15</sup> Although we know that the Samarqand School was still active in 1841-2 (Fazlioğlu, p. 10), we are unsure as to when the Samarqand Observatory was destroyed.

<sup>16</sup> Mu'în al-Dîn al-Kâshî, f. 202 v. We are grateful to Mr. Hamid Bohlul who informed us about this manuscript.



Though, this invaluable *zīj* was translated into French and comments made by Sédillot; only the included star table, has been deeply analyzed, in the last century.<sup>17</sup>

The ruins of the Samarqand Observatory were discovered in 1908 by the Russian archeologist Viatkin. They are placed on top of the hill of Chūpān-Ātā, near Samarqand today. A stony sextant was the only remain of the Samarqand Observatory and a monumental building exists above the sextant in modern architecturally style today (See Plates 1 and 2).

## Appendix

### The Old Persian histories and their English translations

#### حافظ ابرو، ج 4، ص 744، (ذیل وقایع سال 823 هجری):

و هم در این سال (823 ق) حضرت سلطان زاده (الغ بیگ) که در انواع علوم معقول و منقول صاحب کمال است، داعیه آن شد که در ممالک ماوراءالنهر رصدی بندد. کسان که به دست ایشان چنان کاری برآید از شیراز و کاشان و دیگر ممالک جمع گردانیده بدان مشغول شدند.

#### Hāfiz Abrū, vol. 4, p. 744, (The events of the year of 823):

In this year (823 A.H.), his Excellency the Prince (Ulugh Beg), who was perfect in rational and the traditional sciences, intended to establish an observatory in the realm of Transoxiana. [Thus he] gathered people who were able to do such work from Shīrāz, Kāshān and other realms, and they dealt with it.

#### رکن‌الدین شرف‌الدین آملی، گ 1 پ - گ 2 ر:

[گ 1 پ] (س 13) در تاریخ سنه ثلثین (س 14) و ثمانمائه هجریه، سلطان شهید، میرزا الغ‌بیک، انارالله برهانه، در سمرقند بنیاد عمارت (15) رصد کرد و کسانی را که در این علم ماهر بودند، مثل مولانای معظم، ناصب رایات الفضل و الحکم، (س 16) مولانا صلاح‌المله و الدین موسی، المشتھر به قاضی‌زاده رومی، که در علم ریاضی و اصول ماهر و کامل بود [گ 2 ر] (س 1) و جناب مولانای معظم،

<sup>17</sup> For instance, see Knoble, 1917; Shevchenko, pp. 187-201, who has compared the accuracy of the Ptolemy's star catalogue in the *Almagest* and that one in the *Ulugh Beg's Zij*.

غیاث‌الملّة و الدین، جمشید، که در علم هندسه و حساب و اعمال نجومی بی‌نظیر (س 2) زمان بود و استاد جلال‌الدین اصطربلابی که مشهور و معروف بود، در روزگار از ممالک طلبیده (س 3) و ترتیب آلات رصد کرده و دیگر افضل‌المتأخرین، قطب‌المهندسین، مولانا علی قوشچی، تغمده‌الله (س 4) برحمته و رضوانه، را اتفاق شروع افتاد تا در مدت سی سال نشسته، آنچه ممکن بود سعی فرمودند و (س 5) توفیق رفیق شد تا چند سال دیگر استخراج تقویم کرده، احوال قرانات و خسوفات و کسوفات (س 6) و طوابع سال‌های عالم را به آلات رصد تحقیق می‌کردند، که اعتماد کلی حاصل شد.

**Rukn al-Dīn Sharaf al-Dīn Āmulī, fol. 1 v. - fol 2 r:**

In the eight hundred and thirtieth year after Hijra, the Martyr king, Mīrzā Ulugh Beg (may God have helped him to be accountable for his works in eternity and given him reward), [A: founded B: started founding] an observatory in Samarqand. He invited experts in several fields to join his work at the observatory. One of these experts was our supreme lord, who is the standard bearer of superiority and wisdom. Our lord, who was a righteous man in nation and religion, was known as Qāḍī Zāda Rūmī. He was expert in mathematics and knowledgeable of Euclid's *Elements*. In addition our supreme lord Jamshīd, who gives aid to nation and religion, joined the work. He was the very best that could be found among experts in geometry, arithmetic and practical astronomy. The celebrated master Jalāl al-Dīn Uṣṭurlābī, from another region, was invited and joined the work. He designed the astronomical instruments. Another scholar who was a genius in the field of geometry, 'Alī Qūshchī (may God's grace surround him) joined them as well. They decided together to start a thirty year project and give it their very best. The result was that they succeeded in formulating a set of ephemerides<sup>18</sup> some years later. This calendar took into account and examined the conjunctions, eclipses and ascendants of the years according to their astronomical instruments. Their conclusions were found to be very reliable.

<sup>18</sup> We have translated the word "*taqwīm*" into "ephemerides" instead of "calendar", though in some cases, it can be translated into astronomical calendars, which they were like booklets and the calculations from *zīj*es were used in them for astrology purposes.

الغبيک (زیج الغ بیگ، نسخه خطی شماره 3598، گ 177 پ، مجموعه نخجوانی، تبریز):

جدول مواضع کواکب ثابتة در طول و عرض که ما به رصد یافتیم در اول سال  
ضما (= 841) هجری

Ulugh Beg, (Nakhjawānī Collection, ms. 3598, f. 177 v, Tabriz)

This is the table of the positions of the fixed stars according to their longitude and latitude as they were observed at the beginning of the year of 841 after Hijra.

خواندمیر، ج 4، ص 21:

در سنه 824 آن خسرو بی مانند [الغبیگ] در وسط بلده فاخره سمرقند مدرسه رفیع و خانقاهی منیع بنا نموده به اتمام رسانید و بسیاری از مزارع و قری و مستغلات فواید انتما بر آن بقاع وقف گردانید و همچنین فرمان داد استادان کاردان در آن بلده فردوس نشان رصدی بنیاد نهادند و بطلمیوس ثانی مولانا غیاث الدین جمشید و جامع کمالات انسانی مولانا معین الدین کاشی در ترتیب آن بنا سعی و اهتمام دادند و از نتایج آن رصد زیجی مرتب گشت که آن را زیج جدید گورکانی گویند و اکنون اکثر تقاویم را از آن زیج استخراج نمایند.

Khāndmīr, Vol. 4, p. 21:

In the year of 824, the incomparable king [Ulugh Beg], within the center of the glorious city of Samarqand, founded a magnificent school and a lofty *khāniqāh*<sup>19</sup>. After he completed them, he devoted (*waqf*) many farms, villages and properties to support them. He also ordered skillful masters to build an observatory in that heaven-like city of Samarqand. The second Ptolemy, our lord Ghīyāth al-Dīn Jamshīd, and the summation of all human perfections, our lord Mu'īn al-Dīn Kāshī, also made an effort in the preparation of the building. As a result of the work of that observatory, a *zīj* was compiled which is called *New Zīj of Gūrkan*, and currently most ephemerides are extracted from this *zīj*.

<sup>19</sup> *Khāniqāh* is a place where dervishes and mystics gather around to pray and perform rituals.

### حسن روملو، ص 262 (ذیل وقایع سال 824):

در این سال میرزا الغبیک در وسط شهر سمرقند مدرسه عالی بنا نهاد و ملک بسیار بر وی وقف کرد.

**Hasan Rūmlū, p. 262, (The events of year 824):**

During this year, Mīrzā Ulugh Beg founded a magnificent school in the middle of the city of Samarqand and devoted (*waqf*) a large number of lands to its support.

### ابوطاهر سمرقندی، ص 44:

میرزا الغبیک بعد از شانزده سال از ابتدای حکومت خود در سنه هشتصد و بیست و سه این مدرسه را بنا فرمود.

**Samarqandī, p. 44:**

Mīrzā Ulugh Beg, sixteen years after the beginning of his governance, in year eight hundred twenty three, founded this school.

### ابوطاهر سمرقندی، ص 45-46:

. . . و بعد از تمام شدن این مدرسه، میرزا الغبیک قاضی‌زاده رومی را در آن مدرسه مدرس نموده و خود میرزا الغبیک نیز در آنجا درس می‌گفته، و بعد از چهار سال در تمامی این مدرسه میرزا الغبیک در تاریخ هشتصد و سی و دو به اتفاق قاضی‌زاده رومی و مولانا غیاث‌الدین جمشید و مولانا معین کاشی و مولانا صلاح‌الدین موسوی در دامنه کوهک در لب جوی آب رحمت، رصد بر بست و بر اطراف رصد، حجره‌های عالی ترتیب داد و در پایان تل رصد چهار باغ خوب و چینی‌خانه آراسته کرده، اکثر اوقات در آنجا می‌بوده است. در اثنای عمل رصد، آن علمای کبار که مذکور شدند از دنیای فانی به ملک جاویدانی انتقال نمودند و بعد از انتقال ایشان به مشورت علامه قوشچی رصد را تمام ساخت. در تاریخ هشتصد و چهل و یک وضع رقم زیج گورکانی را که در میانه منجمان اعتبار دارد در صفحه روزگار نوشته مستقیم گردانید.

**Abū Ṭāhir Samarqandī, pp. 45-46:**

... And after the completion of the school building, Mīrzā Ulugh Beg appointed Qāḍī Zāda Rūmī as the teacher of this school. Mīrzā Ulugh Beg, himself, taught there as well. Four years after the completion of this school, in year eight hundred thirty two, Mīrzā Ulugh Beg, with the help of Qāḍī Zāda Rūmī, our lord Ghīyāth al-Dīn Jamshīd, our lord Mu'īn Kāshī and our lord Ṣalāḥ al-Dīn Mūsawī<sup>20</sup>, [A: made observations/ B: founded an observatory] on the hillside of Kūhak along the river Raḥmat. Some magnificent chambers surround the whole observatory. At the bottom of the hill where the observatory was located, they also planned and laid out four beautiful gardens. Special display rooms were built for keeping some Chinese dishes and Ulugh Beg was often found spending time there. During their observations of the heavens, the aforementioned great scholars "traveled" from the "mortal world" to the "permanent world". Ulugh Beg, then, completed these astronomical observations with the consulting work of the polymath Qūshchī. In eight hundred forty one Ulugh Beg wrote the *Gūrkanī Zīj*, which is a reliable source among astronomers. Even today, no other *zīj* can be compared to this outstanding work which they compiled.

**عبد الرزاق سمرقندی، ص 236-237 (ذیل وقایع سال 823):**

... و [الغ بیگ] در درون شهر سمرقند موضعی که سردواتیک گویند – وسط بلده و مرکز خطه، نزدیک ارک عالی، اطراف آن بازارهای معمور و خاندان های مشهور – مدرسه و خانقاهی برابر یکدیگر بنا فرمود و چند سال در اتمام آن دو مقام اهتمام تمام بذل فرمود.

**‘Abd al-Razzāq Samarqandī, pp. 237-238, (events of year 823):**

.... In a part of the Samarqand city called "Sardwātīk" in the middle of the city, in the center of the territory, close to the glorious castle, and surrounding it, some bazaars were built and famous families [resided] there in the same area. [Ulugh Beg] founded a school and a *khāniqāh*, each one located in front of the other and he did his best during a number of years to complete the construction of the two buildings.

<sup>20</sup> Writing of this name is an error from the compiler. We know that the first name of Qāḍī Zāda was Ṣalāḥ al-Dīn Mūsā, but Samarqandī wrote it Ṣalāḥ al-Dīn Mūsawī and cited him as a different person from Qāḍī Zāda.

### عبد الرزاق سمرقندی، ص 237-238 (ذیل وقایع سال 823):

. . . میرزا الغبیک که در علوم و فنون، صاحب نصیب اوفی و نصاب مستوفی بود خواست که انوار دانش خویش چون اشراق آفتاب در اقطار آفاق ظاهر گرداند و فروغ ادراک از مقعر خاک به محدب فلک الافلاک رساند و صدای رصد کواکب در گنبد گردون اندازد و طنطنه این کار بزرگ در اطراف ربع مسکون منتشر سازد، بنابراین با خواص حکما و فحول عقلا، مهندسان عطارذکا و فیلسوفان مجسطی‌گشا که در جمیع علوم و حقایق معقول و مفهوم به تخصیص ریاضی و حکمی [۱] عجبیه عصر و نادره دهر بودند، مثل افلاطون زمان، مولانا صلاح‌الدین موسی قاضی‌زاده رومی و بطلمیوس دوران مولانا علاءالدین قوشچی که تربیت یافته میرزا الغبیک بود و به زبان عنایت او را فرزند خطاب فرمود، و این دو محقق دانشمند در سمرقند اقامت داشتند، و مولانای اعظم غیاث‌الدین جمشید، و مولانای معظم معین‌الدین که میرزا الغبیک ایشان را از کاشان به سمرقند برده بود، انجمنی ساخت و در معرفت دقایق تنجیم و ادراک غوامض تقاویم با آن دانشوران که به مدد عقل کل بر کیفیت هر جزئی از اجزای سپهر واقف بودند و به خطوات اقدام مسافر وهم، کیفیت طول و عرض عالم علوی و سفلی می‌پیمودند و در ابعاد و سطوح اجرام هیچ دقیقه مهمل و هیچ ثانیه نامرعی نماند و در ارتفاع درجات مرتبه سخن به فلک الافلاک رسانده سخنان پرداخت.

و بعد از تحصیل کمالات و تکمیل آلات، میل استنباط رصد و استخراج زیج فرمود در شمال سمرقند مایل به مشرق، مقام لایق تعیین نمود و به اختیار حکمای نامدار، طالعی که آن کار را شاید مقرر شد و بنای آن چون اساس دولت پایدار و بنیاد آن چون قاعده سلطنت استوار استحکام یافت، تأکید بنیان و تشیید ارکان چون قواعد جبال تا موعد «یوم تسیر الجبال سیراً» مأمون از زوال و مصون از اختلال آمد، و هیئت افلاک تسعه و اشکال دوایر تسعه و درجات و دقایق و ثوانی تا عواشر و افلاک تداویر و کواکب سبعة سیاره و صور کواکب ثابته و هیئت کره ارض و صور اقالیم با کوه‌ها و دریاها و بیابان‌ها و آنچه از توابع آن باشد به نقوش دلپذیر و رقوم بی‌نظیر در درون خان‌های آن عمارت عالی‌بنیاد رفیع نهاد که نمودار قصر مقرنس سبع شداد بود ثبت و تحریر فرمود، و تقویم آفتاب و سایر کواکب را رصد کرده بر

زیج جدید ایلخانی که جناب حکمت‌مآب، خواجه نصیرالدین طوسی استخراج نموده بود، فواید و لطایف افزود و در تقویم آفتاب و کواکب دیگر تفاوت صریح ظاهر ساخت، و حکمای بزرگ در آن مهم نازک مُمد و معاون بودند و آوازه آن امر خطیر در بلاد و امصار اشتهار و انتشار یافت و شاهزاده موفق گردید تا آن زیج تصحیح یافته، تمام رسید و به زیج سلطانی گورکانی موسوم شد و در میان مَهَرهٔ صناعت تنجیم و اصحاب تقاویم، معمول و متداول است.

‘Abd al-Razzāq Samarqandī, pp. 237-238, (events of year 823):

... Mīrzā Ulugh Beg, who was gifted in the physical sciences and research, wanted the radiance of his knowledge shine around the world like the beaming sunrise. He desired to give the light of understanding to people from the lowest lands to the empyrean, and extend the “voice” heard through the observation of the stars in the “sky dome” and around the inhabited quarter of the earth. So he brought together the wisest and the most outstanding geometers along with the masters who could solve the problems of the *Almagest*. These very bright researchers were marvels in their time and were geniuses in all the scientific fields, rational realities and concepts, most particularly in mathematics and wisdom. These prodigies, like Plato in his time, were Ṣalāḥ al-Dīn Mūsā, Qāḍī Zāda Rūmī, (the Ptolemy of the time,) our lord ‘Alā’ al-Dīn Qūshchī, who was trained by Ulugh Beg. Ulugh Beg gave him great attention and even called him “son”. These two scholars resided in Samarqand and our supreme lord Ghīyāth al-Dīn Jamshīd al-Kāshī and our supreme lord Mu‘īn al-Dīn [al-Kāshī] were brought to Samarqand by Ulugh Beg. These scientists could understand the minutes of astrology and the intricacies of the calendar details. They could understand every detail of the sky with the help of God and by “the strength of their creative imaginations” They proceeded to measure celestial longitude[s] and latitude[s] of the superior and inferior heavens. Every detail was considered in measuring the distances and surfaces of the celestial bodies and no second was left unaccounted for.

After he planned, designed and saw the completion of the building of astronomical instruments, Ulugh Beg desired to infer from the observations and compiled a *zīj* (astronomical handbook with tables). He determined a suitable place in the north-east of Samarqand for constructing an observatory. The appropriate horoscope (*tālī*) for constructing the observatory was cast by famous astrologers

and, then, the observatory was built and set on a firm foundation like the groundwork of an enduring government. Its establishment became durable like the foundation of a monarchy. Being built so solid, like the base of mountains that will endure till the day in which the mountains are moved by God (the day of resurrection), the observatory was protected from destruction and became enduring. Ulugh Beg ordered to draw, on the walls of the observatory chambers, diagrams and representations of the nine orbs, degrees, minutes, the seconds till the tenth [order], the epicycles, the seven planets, the depictions of the fixed stars, the globe of the earth, the climates (*aqālīm*), mountains, seas and deserts and what follows them. These walls were a picture of heaven itself. Ulugh Beg observed the longitudes of the sun, stars and planets, and he also added some useful points to the *Īlkhānī Zīj* of the great man, Khājah Naṣīr al-Dīn Ṭūsī. Ulugh Beg showed some concrete discrepancies in longitude of the sun and other planets and stars between the new *zīj* and the *Īlkhānī Zīj*. The great scholars already mentioned helped to continue this important work. The notability of this great work became prevalent in the cities. The prince was able to complete that modified *zīj* and it was called: “the *Sultānī Zīj of Gūrkan*”. It is now common among most of the astronomers and experts in the computation of ephemerides.

### قزوینی، ص 316:

میرزا الغ بیک بن شاهرخ میرزا، پادشاه فاضل عالم عالی‌مقدار بود، در اقسام ریاضی مهارت داشت، در سنه 823 به اتفاق مولانا صلاح‌الدین موسی قاضی‌زاده رومی و مولانا علی قوشچی که شارح تجرید است و مولانا غیاث‌الدین جمشید و مولانا معین‌الدین که ایشان را از کاشان به سمرقند آورده بودند در شمال سمرقند مایل به مشرق رصد بست و زیج خانی که در این ایام مدار استخراج تفاوتیم بر آن است از مصنفات اوست.

### Qazwīnī, p. 316:

Mīrzā Ulugh Beg ibn Shāhrukh Mīrzā, who was a scientist king, knowledgeable and skillful in all the different fields of mathematics. Along with our lord Ṣalāḥ al-Dīn Mūsā Qāḍī Zāda Rūmī, our lord ‘Alī Qūshchī (who described the *Tajrīd* [-e *Uṣūl*]), our lord Ghīyāth al-Dīn Jamshīd and our lord Mu‘īn al-Dīn, were brought to Samarqand from Kāshān, A: They founded an observatory/ B: made observation(s)]



in the north-east of Samarqand in the year 823, and the *Khānī Zīj*,<sup>21</sup> which is the basis of today's ephemerides, is one of their compilations.

### میرخواند، ص 5359-5361:

... و در خلال این احوال میرزا الغبیک در وسط بلده فاخره سمرقند به بنای مدرسه‌ای عالی و خانقاهی رفیع فرمان داد و از مستغلات و مزارع و قریه چندان بر آن وقف کرد که بعد از استیفای ارباب و ظایف از مدرسان و طلبه علوم و شیخ و حقاظ و عمله آن دو بقعه شریفه حقوق خود در هر سال می‌گرفتند و مبلغی خطیر فاضل می‌آمد و در خزینه آن دو موضع محفوظ می‌گشت.

و همچنین فرمان عالی نفاذ یافت تا استادان چابک دست رصدی بنا نهادند و عمده عمله رصد، بطلمیوس ثانی و خلاصه حکمای یونان مولانا غیاث‌الدین جمشید و جناب فضایل‌مأب مولانا نظام‌الدین کاشی بودند و در اندک زمانی این عمارت در غایت تکلف و تزئین و رصانت به اتمام رسید و از نتایج رصد زیجی مرتب شد که آن را زیج جدید گورکانی گویند و اکنون بیشتر منجمان تقویم از این زیج استخراج می‌نمایند.

### Mirkhānd, pp. 5359-5361:

... And during this time (at the beginning of year 824), Mīrzā Ulugh Beg ordered that a great school and *khāniqāh* should be established. He devoted some farms and villages to support them. The authorities paid the salaries of teachers, science students, the patriarch, students memorizing the Qur'ān, and various other workers in the school and *khāniqāh*. Even after all these salaries were paid, a considerable amount of money was able to be saved in the treasuries of these two locations.

Ulugh Beg ordered the scientific experts to found an observatory. The most significant of them was the successor of Ptolemy and a contender to the best of Greek scholars, Ghīyāth al-Dīn. Along with the honored sir, our lord Nizām al-Dīn<sup>22</sup> al-Kāshī, they completed the founding of the observatory with the greatest level of luxury, extravagance, and permanence in a short period of time. As a result of the observations made at this location a *zīj* was prepared which is called the *New*

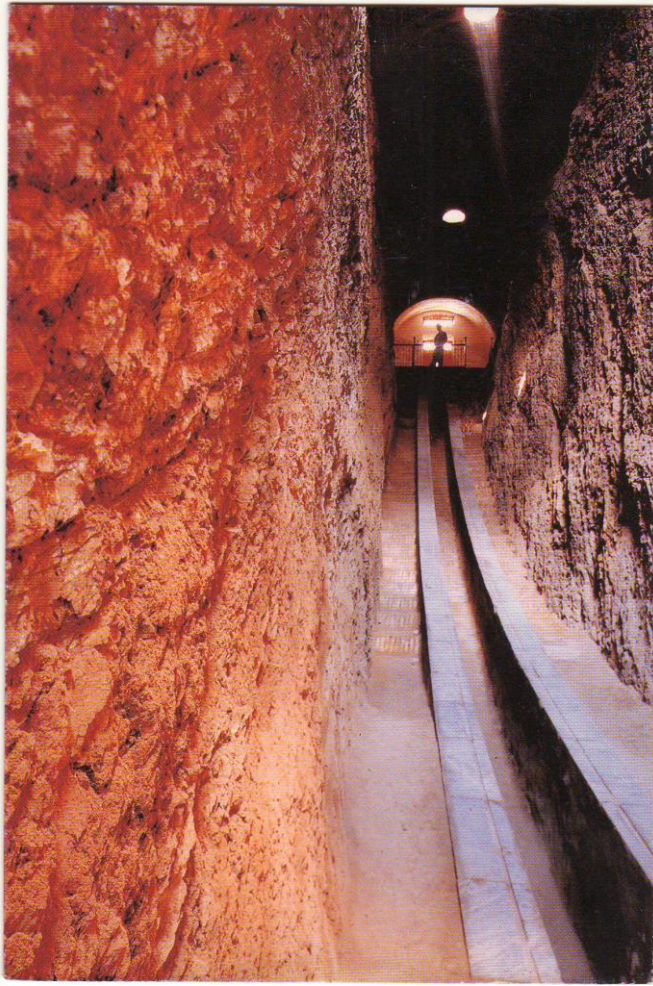
<sup>21</sup> It means *Ulugh Beg's Zīj*.

<sup>22</sup> This name has to be Mu'īn al-Dīn, and the author mentioned it erroneously.

*Gūrkānī Zīj* and, now, most astronomers determine the details of the ephemerides using this *zīj*.



**Plate 1:** A view of the modern building on top of Ulugh Beg's Sextant.



**Plate 2:** The remains of the stony sextant of the Samarqand Observatory (front view).

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